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# THESIS

COMPONENT OBSOLESCENCE: PRESENTATION OF A DECISION PROCESS FOR ASSESSING AND SELECTING ALTERNATIVE SOLUTIONS APPLICABLE TO MAJOR WEAPON SYSTEMS PRODUCTION

by

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The capability to maintain and sustain military forces in peacetime deterrence and mobilization missions relies heavily upon the continued availability of system components. Advancing technology threatens operating system and production support as older system designs become increasingly dependent upon obsolete technology. This thesis focuses upon situations in which the contracting officer is informed by the prime contractor that a subcontractor no longer plans to continue manufacturing a particular component needed to support a major weapon system production line, and the alternative courses of action which can be taken when this occurs. The study defines the obsolescence problem and discusses why it occurs, describes current management initiatives and procedures to lessen the

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# Component Obsolescence: Presentation of a Decision Process for Assessing and Selecting Alternative Solutions Applicable to Major Weapon Systems Production

by

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## ABSTRACT

The capability to maintain and sustain military forces in peacetime deterrence and mobilization missions relies heavily upon the continued availability of system components. Advancing technology threatens operating system and production support as older system designs become increasingly dependent upon obsolete technology. This thesis focuses upon situations in which the contracting officer is informed by the prime contractor that a subcontractor no longer plans to continue manufacturing a particular component needed to support a major weapon system production line, and the alternative courses of action which can be taken when this occurs. The study defines the obsolescence problem and discusses why it occurs, describes current management initiatives and procedures to lessen the impact, identifies advantages and disadvantages associated with each alternative, and develops a formalized decision process for problem resolution.

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# I. INTRODUCTION

## A. FOCUS OF THIS STUDY

The capability to maintain and sustain military forces in peacetime deterrence and mobilization missions relies heavily upon the continued availability of system components. Advancing technology threatens operating system and production support as older system designs become increasingly dependent upon obsolete technology. This study will focus upon situations in which the contracting officer is informed by the prime contractor that a subcontractor no longer plans to continue manufacturing a particular component needed to support a major weapon system production line, and the alternative courses of action which can be taken when this occurs.

## B. OBJECTIVES

The primary intent of this research is to provide contracting officers with an overview of the component obsolescence problem, and to develop a formalized procedure for selecting the most feasible available alternative. The study is organized to define the problem and discuss why it occurs, describe current management initiatives and procedures to lessen the impact, identify the advantages and disadvantages associated with each alternative, and develop a formalized decision process for problem resolution.

## C. RESEARCH QUESTIONS

In consonance with the objectives stated above, the following research question is addressed:

> What are the principal alternatives available to the Government to accommodate situations in which sources of supply for major weapon systems components are no longer available, and how might these alternatives be analyzed to result in the best course of action?

In support of the primary research question, the following subsidiary questions are addressed:

1. What are the typical conditions under which subcontractors are no longer sources of supply for major system components?

2. What alternatives are available to resolve the problem of a subcontractor's discontinued production of a major system component?

3. What are the key factors involved with selecting an alternative source of production, and how should these factors be used in the analysis?

4. What is the decision process that could be used in selecting the best alternative?

## D. RESEARCH METHODOLOGY

This study analyzes the problem of discontinued subcontractor production lines from the perspectives of the contracting officer and the prime contractor. The information used throughout this study was derived from personal interviews of contracting, logistics, engineering, and production personnel at the Naval Air Systems Command Headquarters (NAVAIR) and Grumman Aerospace Corporation (GAC), and telephone interviews with project engineers from the Naval Avionics Center (NAC) and the Naval Ocean Systems Center (NOSC).

The literature utilized in this study includes information obtained from the Defense Logistics Information Exchange (DLSIE), current Federal and Department of Defense (DoD) regulations and supporting directives, previous theses, and a review of current publications and periodicals relevant to the subject of obsolescence.

This study has been designed as an inquiry to assist decision-makers in choosing preferred courses of action by (1) systematically examining alternatives for resolving the obsolescence problem, and (2) selecting the most feasible alternative.

The researcher relied primarily upon information obtained from NAVAIR and Grumman personal interviews. Interviewees described specific situations involving obsolescence problems and discussed alternatives available at the time of occurrence. The researcher examined existing procedures for resolving the problem, as well as actions taken to resolve the problem which appeared to deviate from established procedures. The generally applicable considerations which comprise the major portion of this thesis are substantially based upon actual obsolescence problems experienced by NAVAIR and Grumman.

## E. SCOPE OF THIS STUDY

This study is limited to an examination of problems associated with subcontractor discontinuation of major weapon system component production in the aerospace industry and its subsequent affect on major weapon system production lines. Illustrative examples are limited to microcircuit components

which are considered to be vital to the uninterrupted flow of major weapon system production lines, primarily F-14 aircraft production. The selected components represent situations in which criticality is a major factor. For example, the subcontractor is the sole source for the component, and the production schedule will be affected unless action is taken.

Discussion of the various alternative solutions is limited to actions which would be taken by the Government and/or the prime contractor to resolve a particular production-related problem. The process of identifying total system requirements and coordinating the resolution decision with all affected item managers is not within the scope of this study.

Although this study is limited to electronics parts obsolescence, it is intended to serve as a model for all components acquired for production line support. The findings, conclusions, and recommendations should be regarded as oriented toward the overall problem, not limited only to electronics.

## F. LIMITATIONS

No significant limitations were encountered during the course of this research. It is felt that sufficient interface with personnel who formulate and execute obsolescence procurement decisions within the Department of the Navy was achieved to ensure that the most salient concerns related to the purpose of this research were addressed.

## G. ASSUMPTIONS

It is assumed that the reader is familiar with basic procurement problems, basic naval terminology, and general contracting and acquisition procedures for major systems.

## H. DEFINITIONS

The format of this study includes relevant definitions within the body of each chapter. Terminology associated with the semiconductor industry is defined when considered necessary to assist with the clarification of particular discussions. Descriptions of electronic items or processes are provided at a general, nontechnical level.

## I. ORGANIZATION OF THIS STUDY

This thesis is organized for the reader to acquire a general understanding of the nature and implications of the obsolescence problem. Major research areas concern the importance of the problem, why it occurs, how it is currently managed, a detailed discussion of available alternatives, and a recommended process for selecting the most feasible alternative.

Chapter II provides the necessary background for the establishment of a general setting for the focus of this effort. Chapter III examines and discusses current policies and procedures for managing the problem. Chapters IV and V analyze the alternatives by using factors, and identify advantages and disadvantages associated with each alternative. Chapter VI offers a general decision-making strategy, and concludes with

a decision model which matches the available alternatives with the decision-determining factors. The researcher's conclusions, recommendations, and answers to the research questions are provided in Chapter VII.

# II. BACKGROUND

## A. INTRODUCTION

Though problems caused by the obsolescence of technologies used in modern weapon systems are not new to acquisition and logistics managers, the problems associated with the obsolescence of microelectronic circuits are exceptionally acute due to the rapid growth of semiconductor technology, and the extensive use and dependence on microelectronic circuits in military weapon systems [Ref. 1:p. 1].

This chapter will describe two main causes of microcircuit obsolescence that affect the continued production of military weapon systems. The first part of the chapter discusses the different life cycle lengths of semiconductors and military weapon systems, and the second part will describe the lack of Governmental influence upon the semiconductor industry.

## B. LIFE CYCLES OF SEMICONDUCTORS AND MILITARY SYSTEMS

In the context of this research, microcircuit obsolescence occurs when the last known manufacturing source stops producing a microelectronic component that is still needed to support military weapon systems in production [Ref. 1:p. 1]. This is becoming an increasingly common occurrence because the production life cycle for each type of integrated circuit (IC) is approximately ten years, whereas the military may produce a system dependent upon a certain type of integrated circuit for

15 to 20 years [Ref. 2:p. 7]. The reason that the production life cycle for each type of integrated circuit is relatively short is largely due to the rapid advance of integrated circuit technology. In a few years, the electronics industry has advanced through a number of distinct technology phases. For example, the vacuum tube was used extensively until 1947 when the solid state transistor was developed. The transistor was a "small, low-power amplifier that replaced the large, power-hungry vacuum tube" [Ref.3:p. 63]. In 1959, the integrated circuit was developed, and has subsequently progressed through various levels of integration. The IC is composed of chips, or dice (singular die) formed on a plane of semiconductor material. In small scale integration (SSI) each chip contained ten to twenty transistors designed to perform a specific function. [Ref. 4:p. 10] Within a few years, MSI (medium scale integration) was replacing SSI. With MSI, the same size die could contain hundreds of transistors with associated circuitry required to perform more sophisticated functions. Next came LSI (large scale integration) which is used widely in sealed assemblies called hybrid microcircuits in which many chips can be interconnected to form a sophisticated custom circuit for use in a military system. [Ref. 2:pp. 2-5] LSI circuits contain up to 250,000 components and perform extremely complex operations. The LSI microelectronic circuit category also includes microprocessors. These are computer central processing units on a single chip. [Ref. 4:p. 11] Additional technological

advancements include very large scale integration (VLSI) and very highspeed integrated circuits (VHSIC).

Each phase of technology experiences distinct life cycle stages. Leopold identifies the stages as [Ref. 5:p. 42]:

1. Design-in and preproduction
2. Growth
3. Maturity
4. Decline
5. Phase-out

In the commercial electronics industry, "annual or biannual redesigns are not uncommon" [Ref. 6:p. 8]. Commercial customers are able to keep pace with the rapid advance of microcircuit technology and purchase components in the first two life-cycle stages when they are regarded as state-of-the-art. In contrast, the Government has typically depended upon systems designed to last up to 30 years. Though producers of military electronics systems may have originally designed systems incorporating state-of-the-art technology, they are forced in later years to become dependent upon components in the decline and phase-out stages because industry phases the older items out of production in order to "place available engineering, design, and production capability on current or projected technology" [Ref. 7:p. 21]. F-14 avionics, for example, reflect 10-15 year old designs, and F-14 production line support problems are becoming increasingly critical as the need grows to procure components which are in the decline and phase-out portions of their life cycles [Ref. 8].

The contrast between the life cycles of individual types of semiconductor technology and the Government's continued production of systems designed with technology which is phased out well before the system life cycle is complete makes it apparent that electronic parts supplied for defense needs are going to be behind current development [Ref. 6:p. 8].

## C. GOVERNMENT INFLUENCE ON MICROCIRCUIT TECHNOLOGY

In addition to the disparity between component and system life cycles, the microcircuit obsolescence problem currently experienced by the military is partially caused by the recent lack of Governmental influence on the direction of microcircuit technology, and the small Governmental share of the microcircuit business in comparison to the commercial share of the market.

End markets for semiconductor products have changed since the early 1960's. At that time, military applications dominated the field, military chips comprised 70 percent of the total available market, and most integrated circuit development was keyed to military needs. Specification, testing, and qualification processes developed during that period continue to influence today's semiconductor industry. [Ref. 9:p. 148]

Though direct military research and development funding leveraged heavy corporate investment, the commercial marketplace also contributed significantly to the large development costs and the capital intensive manufacturing processes. There was a situation of many sellers, many buyers and healthy competition.

The military not only influenced the direction of development, but benefitted from the small, inexpensive, and increasingly reliable high technology components which were developed as a result of private sector demand. [Ref. 2:p. 4] Military influence on the direction of semiconductor technology and product definition had practically vanished by the 1970's; the Department of Defense share of the IC marketplace is currently estimated at less than five percent [Ref. 2:p. 7]. An internal document from Veda Corporation partially intended to summarize the obsolescence problem identifies several reasons for the reversal of market development control. These include the fact that the DoD is supporting older technology not profitable for the commercial sector to continue to produce, and the perception that the Government is not a good customer for the microelectronic circuit industry [Ref. 1:p. 1]. Production runs are low, Government specifications, regulations, and paperwork are troublesome, profit margins are perceived to be low, and there are sometimes payment delays [Ref. 1:p. 2]. In addition,

> the developers of new weapon systems normally require specialized microelectronic circuits to maximize performance or to provide unique features and capabilities, and the microcircuit design and development process is characterized by intellectual intensity with high front-end costs for research and development. This further induces microelectronic circuit manufacturers to focus their resources in the more profitable commercial segments of the marketplace. [Ref.1:p. 2]

The consequence of dwindling Government influence upon the semiconductor industry is that commercial development efforts focus upon commercial interests such as data processing, rather than upon the Government's signal processing needs [Ref. 10:p. 52].

## D. SUMMARY

The occurrence of technology obsolescence is a natural evolutionary process. "At some point in any produce life cycle, demand will wane, with obsolescence just beyond the horizon" [Ref. 10:p.51]. The problem has a particularly acute effect upon the military because military systems are designed to last for a period much longer than the semiconductor technology life cycles. In addition, DoD is a low volume customer compared to the commercial sector, and has recently had little influence upon the direction of microcircuit technology development.

# III. MANAGEMENT POLICY

## A. INTRODUCTION

The dramatic growth in leading-edge semiconductor technology has made it difficult for the military to obtain parts needed to support military electronics systems. Parts rapidly becoming obsolete are needed to support systems sometimes designed to last 30 years. [Ref. 5:p. 42] The Navy has established microcircuit obsolescence management policy which defines the problem, initiates a comprehensive management program, identifies alternative solutions to the problem, and encourages designing standardization into future military systems.

The scope of this research limits discussion of the Navy microcircuit management policy to Naval avionics associated specifically with the production of major weapon systems. The first part of this chapter will identify facets of the microcircuit obsolescence problem which prompted the issuance of a comprehensive policy. Aspects of the Navy's microcircuit obsolescence directive and established procedures relevant to production line considerations will be highlighted in the second part of this chapter, and the prime contractor's internal procedures for assessing the impact of the problem and analyzing various alternatives will comprise the third part. The chapter will conclude with a description of activities performed by the program office and the prime contractor to cooperatively

coordinate problem resolution by selecting the "best" available alternative.

## B. MANAGEMENT CONCERNS

The Naval Air Systems Command (NAVAIR) Microcircuit Obsolescence Management Committee separated elements of the problem into four general areas. These areas are identified and discussed below with particular emphasis placed upon their relevance to the research questions.

### 1. Elements Related to the Problem

IC manufacturers terminate production of older, less profitable microcircuit devices after approximately three to five years of production; however, the devices need to be supported in NAVAIR systems for 10 to 15 years. NAVAIR must identify and analyze alternative solutions to the problem which include finding another source, redesign, and a lifetime buyout of remaining components. Analysis of solutions is frequently timeconsuming, and implementation can be expensive. [Ref. 11]

### 2. Elements Related to Inadequate Communication

There is no way to predict with certainty when a particular component will become obsolete. IC manufacturers may provide notification of plans to terminate production, but they have no formal obligation to notify component users of planned production termination, and the time provided between notification and final production termination is frequently not sufficient to allow analysis of the situation and implementation of an appropriate alternative. Additionally, IC manufacturers do not

always know who the component users are, and would not be able to provide anything other than scattershot notification to contractors who might be using the component in their systems. [Ref. 11]

3. Elements Related to Inadequate Visibility

It is difficult to determine the composition of devices in modules or assemblies stocked at other than the piece part level. Non-repairable modules, contractor-supported assemblies, most hybrid devices, commercial equipment, and systems not organically repaired by the Navy do not have individual micro-circuit component visibility to the Navy. This hinders the search for substitutes or for other manufacturers who require specifications to produce the component. [Ref. 11]

4. Additional Problems Related to Systems in Production

The program manager may be unaware of the system impact which will be caused by the obsolescence of a particular micro-circuit because there is no application visibility for that particular component. Funding for the resolution of obsolescence problems is unbudgeted and money necessary to implement solutions, particularly life-time buyouts, must be redirected from budgeted uses. [Ref. 11]

The problems cited above provide a brief synopsis of the types of concerns the microcircuit obsolescence problem evokes. Of critical concern is the possibility that production line processes will be slowed or halted while solutions to the problem are being analyzed and implemented.

## C. DIRECTIVES AND ESTABLISHED PROCEDURES

Recognizing the need to manage the microcircuit obsolescence problem, the Navy established formal management policy with the release of NAVMAT Instruction 4800.41, "Microcircuit Obsolescence Management," dated 16 February 1983. This instruction applies to the design, development, production and modification of major weapon systems and end items using microcircuit components. It mandates the establishment of a centralized management system to interface with industry, operate a microcircuit application data retrieval system and maintain long-term microcircuit storage, and designates Commander, Naval Air Systems Command (COMNAVAIRSYSCOM) as the lead systems command for coordinating microcircuit obsolescence functions.

Specific program objectives cited in the instruction are to [Ref. 12:p. 2]:

1. Minimize the impact of production terminations of microcircuit devices upon Navy systems through prompt and timely action to ensure support of present and planned requirements.

2. Provide the means for identifying and/or verifying microcircuit end item application in new and existing Navy equipment through the development and operation of a centralized computer data base.

3. Improve the timeliness of response to microcircuit changes/deletions etc., received from manufacturers by establishing procedures for proper assessment of available alternatives.

From the perspective of resolving production-related microcircuit obsolescence problems, these objectives set the stage for definitive programs designed to identify and document

the microcircuit composition of Navy weapon system assemblies, and to establish procedures for analyzing and selecting various alternatives. As the designated lead systems command, NAVAIR was assigned the responsibility to [Ref. 12:p. 3]:

1. Provide overall policy and guidance for the establishment and operation of the SYSCOMs' microcircuit obsolescence management programs.

2. Serve as the single point of contact for interface with the microcircuit industry.

3. Manage the development, implementation, and operation of a secured centralized data base system for obsolescence and related microcircuit technology issues for use by all activities.

4. Support the development, establishment, and operation of secured centralized long-term microcircuit storage facilities for use by all activities.

As directed,NAVAIR initiated a comprehensive tracking, control,and support system to deal with the microcircuit obsolescence problem. The program was developed by the Naval Avionics Center (NAC) in Indianapolis, Indiana and is identified by the acronym COMPRESS/IMPACT which stands for COMmercial PRoduction of Electronic Solid-state Systems Impact of Microcircuit Part Obsolescence on Avionics Critical Technology. [Ref.2:p.10]. The COMPRESS portion of the program relates to engineering and application controls for new technology and is beyond the scope of this research. The IMPACT portion of the program is directly relevant to the program objectives and NAVAIR responsibilities concerning production support obsolescence problems, and provides a process to interact with IC manufacturers, formalize an impending obsolescence problem

notification system, identify microcircuit components in all NAVAIR weapon systems, and determine and analyze appropriate alternative solutions.

The IMPACT portion of the program relates to configuration tracking and integrated circuit obsolescence warning notices. NAC accumulates data concerning technology types, suppliers, number of types, part numbers, and quantities of each type present in each weapon replaceable assembly in NAVAIR weapon systems. This data is entered into the IMPACT high technology data base. The data interrelate as much as possible to assist with the determination of which weapon systems are affected by the obsolete microcircuit. [Ref. 2:p. 12]

NAC personnel maintain close liaison with microcircuit producers, and attempt to ensure that NAC is notified if plans have been made to stop producing a particular microcircuit. When informed that this situation will occur, NAC compiles as much information as possible about the affected microcircuits by searching the data base to determine which subsystems are affected, and then issues a standardized notification to affected users identified through the data base search. [Ref. 2:p. 14] Two basic types of notification are issued, IMPACT Warnings and IMPACT Alerts. If the producer is not the last known source, IMPACT Warnings are issued to program and logistics managers to report equipment and systems which use the microcircuits terminating production. If the microcircuit producer terminating production is the last known source for the item, NAC issues

an IMPACT Alert to NAVAIR, NAVAIR field activities, NAVAIR contractors, the Defense Supply System and all other interested personnel identifying the specific impacted equipment. [Ref. 13] IMPACT Alerts are most relevant to the scope of this research.

NAC's policy of closely interfacing with all avionics microcircuit producers ensures that the producer includes NAC when notifying customers of production termination plans. Since NAC and the customers learn of the manufacturer's decision at the same time, the IMPACT Warning or Alert lags the initial producer notification by the amount of time sufficient for NAC to search the data base and compose the letter. The issuance of the Warning and Alert notices signifies that the Government is aware of the problem and has used the comprehensive microcircuit data base to identify affected equipment and users. The NAC notifications may reach customers and users unknown to the original producer, and provide application data relevant to the situation which the original producer would not possess.

The prime contractor may receive word of the obsolescence problem from an affected subcontractor and begin work on the solution prior to receipt of the IMPACT Warning or Alert, and may be able to resolve the problem without elevating it to higher visibility. For example, it may be possible to convince the producer to continue production, identify a substitute, arrange to produce the product internally, or identify and initiate procedures to contract for the requirement with

another source. However, if the producer is the last source, there will be no other sources. The prime contractor may elevate the problem to the NAVAIR program office which should have been alerted to the problem by the IMPACT Alert. The program office utilizes technical, logistics and contracting resources within NAVAIR to analyze the problem, and considers the prime contractor's recommended solution prior to making a decision.

## D. CONTRACTOR PROCEDURES

For the purposes of this research, the procedures that Grumman Aerospace Corporation uses to analyze obsolescence alternatives were examined. F-14 avionics reflect 10-15 year old designs which are directly affected by potential production line shutdown caused by the microcircuit obsolescence problem. Grumman receives 40-50 IMPACT Warnings and Alerts per year and approximately 25 parts per year affect the F-14 avionics. [Ref. 8] The thoroughness of the analysis is frequently affected by the amount of time between the producer's notification and the established date for the last buy. There may not be enough time to engage in comprehensive analysis. A short time period in which to respond affects the time available to effectively [Ref. 8]:

1. Perform the impact assessment,
2. Determine the preferred alternative,
3. Formulate a well thought-out recovery plan.

Acting within these typical time constraints, Grumman has a plan of action for assessing the problem. The following is paraphrased from an inter-office memorandum [Ref. 14:p. 1]:

1. When notification is received that certain electronics components vendors will not produce parts after a specified period of time, and lower-tier subcontractors have "exhausted all internal resolutions to the problem without success, Procurement shall identify the problem for action.

2. "Engineering and Integrated Logistics Support (ILS) shall conduct independent investigations to determine if alternate sources or equivalent parts exist." If alternate sources or suitable substitutes are found to exist, engineering changes to accommodate the new components will be initiated.

3. If no alternate sources or equivalent components can be identified, the merit of redesigning the systems affected by the obsolete component will be investigated, as well as the feasibility of proceeding with an "end-of-life" inventory procurement of the affected components [Ref. 14:p. 2].

An examination of the foregoing procedures reveals that the prime contractor's procedures are designed with two objectives in mind:

1. Resolve the problem at the lowest sub-tier level possible,

2. Identify a solution which will least affect time, cost, and system configuration.

Prior to identifying the problem for prime contractor action, Grumman management personnel ensure that attempts have been made to resolve the problem at the subcontractor level most directly affected by the obsolescence problem. When the problem is elevated to the prime contractor level, efforts are first made to identify alternate sources or suitable substitutes. The last options considered are system redesign to accommodate the use of alternate components and end-of-life buyout. This

alternative consideration sequence matches increasing concerns regarding time, cost, and system configuration which are discussed in detail in Chapters IV and V of this research.

Recommendations to proceed with an alternative involving additional funding or configuration changes must be provided to NAVAIR for use in making the final decision [Ref. 15].

## E. RESOLUTION ACTIONS

The selection of the most appropriate alternative for resolving each microcircuit obsolescence problem involves the consideration of recommendations from both the prime contractor and organizational components within NAVAIR. Grumman submits the recommendations to the program office, and the technical, logistics and contracting areas of NAVAIR coordinate internally to decide upon the best course of action. Alternatives range from arranging for the prime contractor to produce the item to utilizing or developing Government in-house manufacturing capabilities. The most frequently suggested options for quick problem resolution are buying out quantities expected to be needed for the life of the system, and redesigning to accommodate the change. Other options requiring more leadtime include emulation, competition, and development of an alternate source. [Ref. 16]

The remainder of this thesis will discuss each of these alternatives in greater detail by highlighting advantages, disadvantages and considerations typically associated with each

option, and presenting a decision process for selecting the best alternative.

## F. SUMMARY

The problems associated with obsolescence most relevant to production concerns were identified as inadequate communication regarding notification of production termination, insufficient time to conduct an analysis of the alternatives prior to the "last buy" opportunity, poor visibility of component composition, and uncertainty as to the system impact of each obsolescence situation. As the designated lead systems command, NAVAIR established a program entitled COMPRESS/IMPACT to foresee, mitigate and resolve obsolescence problems. The IMPACT portion of the program provides for liaison with vendors, the establishment of a comprehensive data base, and user notification of production termination and impacted systems and equipment. At the time each obsolescence problem occurs, alternatives for resolving the problem are identified, analyzed and implemented before the system production line is forced to shutdown. The prime contractor either resolves the problem internally, or conducts as much analysis as possible prior to elevating the problem to the program manager's level.

## IV. DISCUSSION OF ALTERNATIVES: SOURCE SOLUTIONS AND ENGINEERING SOLUTIONS

### A. INTRODUCTION

This chapter and the following chapter are intended to provide a discussion and analysis of the most relevant alternatives available to the program manager when the last known source reveals plans to discontinue production. Alternatives presented in these chapters are those which can be chosen at the time the problem actually occurs. For discussion purposes, they are grouped into four categories:

1. Source Solutions
   a. original producer
   b. contractor find another source
   c. Government find another source
   d. development of new source
   e. specialty house
   f. in-house production
2. Engineering Solutions
   a. substitution
   b. emulation
   c. redesign
3. System Solutions
   a. Navy supply system
   b. cannibalization
4. Stockpile Solutions

a. buyout production life-time quantity

b. buyout until redesign

c. buy semi-finished product

Each category is organized as a four-part section. The alternatives are identified and discussed in the first two parts with particular emphasis placed upon the perspective most useful to the contracting officer. For example, the section on stockpile solutions focuses upon actual contracting problems encountered in the buyout process. The third part of each section examines relevant factors to be considered in assessing each alternative and the fourth part concludes the section by summarizing advantages and disadvantages associated with the alternatives. The discussion of categories has been split between two chapters because the first two categories are closely associated with the contractor's decision making process (with the exceptions of competitive procurement, and Governmental source development and in-house production), and the last two categories are generally resolved at a Governmental level.

## B. SOURCE SELECTIONS

### 1. Identification

#### a. Continue with Original Producer

The impending disruption of production line processes will not occur if the original producer can be persuaded to continue producing the obsolete component. This alternative involves finding out why the subcontractor plans to phase-out

production, and then negotiating an agreement which will motivate the subcontractor to reconsider plans to cease production.

b. Contractor or Government Find New Source

The nature of component obsolescence generally precludes the existence of other sources since obsolescence is caused when the last remaining producer ceases production. An attempt to locate other sources may be successful if specifications are relaxed or requirements are modified. The search for other sources is facilitated when the prime contractor has originated the component specifications because the prime contractor is familiar with potential sources and can tailor the contract specifications accordingly. If the Government has provided the specifications, the resolution will be elevated to the Governmental level and competition will be utilized.

c. Development of New Source

Developing a new source is closely related to finding another existing source in the sense that contract modifications may be necessary to attract other producers. The source can be developed by the Government or the contractor, though it is assumed that Government funds will be used in either case.

d. Specialty House

Other sources may be discovered by seeking suppliers who specialize in out-of-production components. These suppliers generally buy the completed components for resale, but may manufacture as well as distribute obsolete parts.

d. In-House Production

There are three types of in-house production:

(1) Government Owned-Government Operated (GOGO) facilities,

(2) Government Owned-Contractor Operated (GOCO) facilities,

(3) Prime contractor developed in-house capability.

2. Discussion

Analysis of the source solutions category is suited to progressive consideration of the various alternatives. Consequently, the alternatives will be discussed in the sequential manner that they might normally be contemplated.

The obsolescence problem usually surfaces at a subtier level and each contracting tier attempts to resolve the problem before elevating it to the next higher tier [Ref. 17]. Upon encountering impending obsolescence, the affected higher-tier contractor first determines why the subcontractor no longer plans to produce the component. Macaruso identifies the most common reasons as [Ref. 10:p. 50]:

> a. Lack of a cohesive manufacturing standard for military integrated circuits. Rigorous screening standards often represent the only difference between commercial and military products. These standards make it difficult for IC makers to automate processes and techniques, and sometimes result in separately maintained military and commercial production lines.
>
> In a typical setting, a manufacturer [offering] 600 generic designs finds it necessary to create more than 100,000 unique part numbers just to account for differences in screening demanded by various military customers.
>
> b. Inability to justify continued production of circuit designs which are totally obsolete in the commerical sector.

Methods to motivate the subcontractor to continue production include relaxing screening requirements and providing monetary compensation. Many military specifications and

regulatory controls are based upon older technolcgy and have not been updated to deal with integrated circuitry. [Ref. 2: p. 16] The contracting officer may find that it is possible to relax certain screening requirements or specifications to allow the subcontractor to match his defense work more closely with commercial production. If the subcontractor's rationale for discontinuing production reflects concern with producing uneconomical older technology, it may be possible to convince the subcontractor to continue production by offering increased payment for perpetuating older technology. The additional cost incurred as a result of this decision could be considered temporarily acceptable if the reason for convincing the subcontractor to continue production is to allow time to explore less costly, more permanent solutions.

If the original supplier will not continue to produce the item, the next logical step is to search for other existing sources. According to a NAVAIR engineer, the prime contractor is in an excellent position to do this because of extensive familiarity with the industry and the existence of internal investigative methodology [Ref. 18]. Research conducted at NAVAIR and Grumman has indicated that the subtier contractor most directly affected by the impending obsolescence generally initiates the search for another source, especially if contractual agreements exist to provide the component to the next higher level. Lack of success in locating a suitable source causes the problem to be elevated to increasingly higher contract

management levels where consideration is given to relaxing specifications, modifying the requirement, or developing a new source.

In today's procurement environment, competition must be utilized when the obsolescence problem reaches the Governmental resolution level. Initially, there may not be any sources willing to compete for the requirement since only one manufacturer is currently producing the component. The Government can still find ways to stimulate competition by circulating a technical data package; specifying a form, fit and function application; or modifying the requirement to accommodate producers who could compete if particular modifications were allowed.

In spite of creative efforts to stimulate competition, industry attitude concerning the advisability of producing obsolete technology may become an unsurmountable impediment to finding or developing a new source. As part of his memorandum accompanying Recommendation 32 of the Acquisition Improvement Program (AIP), Deputy Secretary of Defense Carlucci said that competition [Ref. 19:p. 10]:

> reduces the costs of needed supplies and services, improves contractor performance, helps to combat rising costs, increases the industrial base, and ensures fairness of opportunity for award of Government contracts.

However, a general conclusion drawn from the research of Professors Greer and Liao is that when industry is prospering, attempts to stimulate competition do not necessarily reduce costs because the contractors are not "hungry" for any type of related work and prefer to selectively pursue desired business

[Ref. 20]. Producing obsolete technology might not appeal to the majority of potential sources if economic conditions are favorable. They may either refuse to compete for the requirement, or demand monetary compensation not consonant with the intrinsic worth of the component. These reactions undermine expected benefits of competition, most notably reduced costs and increased industrial base capability.

Other sources may also be discovered by seeking suppliers who specialize in out-of-production parts, or by developing a source of production either commercially or in-house. Leopold has found that suppliers specializing in discontinued parts are experiencing a brisk business [Ref. 5:p. 43]. Rochester Electronics, Inc., for example, currently maintains an inventory of over 40 million parts, and Lansdale Transistor and Electronics manufactures and distributes obsolete items. To develop manufacturing capability, Lansdale purchased manufacturing and marketing rights to logic parts which are still used in military systems designed in the 1970s. Purchasing arrangements involve the transfer of the entire mask, assembly, test, burn-in tooling and remaining inventory to Lansdale [Ref. 5:p. 43]. In-house production capabilities include current efforts by the Naval Ocean Systems Center to set up a microcircuit production line to reproduce certain types of industry production [Ref. 13].

3. Factors to be Considered

The attempt to convince the original supplier to continue production and the subsequent look into the feasibility of

finding other sources are generally the first steps taken in attempting to resolve the impending obsolescence problem. Personnel interviewed at both NAVAIR and Grumman agree that this approach causes the least disruption to current procedures, but also acknowledge the difficulty inherent in finding another source since the manufacturer causing the problem is generally the last in the field. In determining whether the search for another source will be successful or is worth pursuing, the following factors are relevant to the decision. Factors are restricted to "within category" analysis, and are oriented toward production line considerations. Chapter VI of this study will present factors relevant to "between category" analysis.

The factors have been divided into four sections:

a. Source Motivation

(1) quantity required

(2) duration of production

(3) design stability

b. Specification Problems

(1) complexity of system

(2) component composition

(3) proprietary data rights

c. Affect on System

(1) configuration

(2) test equipment

(3) Integrated Logistics Support (ILS)

d. Other Considerations

(1) specialty house

(2) in-house production

(3) time

(4) cost

The factors in the first section relate to concerns which might be used to favorably motivate current or other sources to produce the obsolete component. Factors in the second section highlight contractual considerations which might be potential problems if not effectively considered before a decision is made, and the third section identifies factors which relate to the actual weapon system and the test and support environments. The fourth section considers the existence or feasibility of particular alternatives and concludes with a discussion of time and cost considerations. For convenience of discussion, factors are occasionally combined.

One factor which normally would be considered in the analysis of all four categories, type of technology, is limited in influence by the scope of this research. As described in Chapter II, the product life cycle moves predictably from state-of-the-art to mature to old technology. Concurrent with the technology evolution is the progression from many manufacturers producing state-of-the-art components to fewer manufacturers producing mature technology components to no manufacturers producing old technology components (unless they are specifically in business to specialize in old technology) [Ref. 16]. The scope of this research is limited to situations in which the last known source announces plans to phase-out production of a

particular component. At that time, it it still within the capability of other manufacturers to produce the component though they may have shifted resources to accommodate more current technology. The problem faced by the contracting officer is not whether existing manufacturers can produce the component, but why they are not interested in producing it. The type of technology germane to this research is mature technology rapidly phasing into old technology.

a. Source Motivation

(1) Quantity Required and Duration of Production. Macaruso states that given the choice between a commercial opportunity with a 20 million unit per year potential and a custom military design worth a 100,000 unit potential, it is not difficult for the manufacturer to decide whose requirements to produce [Ref. 10:p. 50]. This statement provides a comparison between the military and commercial IC market opportunities when state-of-the-art technology is at its peak. Consider the situation when the manufacturer no longer has the commercial market, but the need to produce IC components for military requirements continues. In this situation, quantity may not be as important to the manufacturer as the amount of monetary compensation since the quantity of microcircuit components traditionally procured by the military has seldom been significant in relation to the manufacturer's commercial business [Ref. 6: p. 8]. The quantity and duration of production could affect the manufacturer's motivation in two ways:

(a) The larger the required quantity and the longer the period that the quantity will be required, the more likely that a manufacturer will accept the commitment to produce the component. [Ref. 19:p. 16]

(b) The smaller the quantity, the shorter the period it will be required, and the higher the compensation, the more willing the manufacturer will be to produce the component. [Ref. 16]

The first reaction takes into account the typical considerations manufacturers think about prior to production commitment (sufficient quantity, guaranteed business), while the second reaction considers aspects peculiar to the obsolescence problem, most notably the reluctance to be committed to the production of obsolete technology for an extended period of time. If the manufacturer reacts in the latter manner, the contracting officer could use the additional time gained from the short period of low quantity production to explore other alternatives.

(2) Design Stability. The assurance that the system and component design will remain stable will be a positive consideration when the manufacturer is making a decision whether to continue or to commence production. If the manufacturer knows that the Government has no plans to discontinue producing the weapon system using the component and that the subsystem will also remain unchanged, the manufacturer will feel confident that the requirement is virtually guaranteed on a longterm basis.

b. Specification Problems

(1) Complexity of System. The contracting officer will encounter increasing difficulty ensuring that contract specifications are adequate while seeking other sources or

developing a new source if the composition of the component or the system with which it interfaces is complex. Modifications to requirements or the relaxation of screening requirements could involve extensive and time-consuming investigation prior to implementation, the intention to rely upon form, fit, and function applications or dependency upon technical data packages may be overly optimistic if technological "know-how" cannot be successfully transmitted through written documentation, and in-house production capability may not exist or be too costly to develop if the component is particularly unique.

(2) Component Composition. It may not be possible to determine the composition of the obsolete component. Plans to use competition may be imperiled if the design data package does not exist or is not updated. The component may also be composed of various hybrids, each with unknown individual component compositions.

(3) Proprietary Data Rights. If the design is based upon privately-funded research and development, the developer may be reluctant to release the design [Ref. 19: p. 17]. This will cause problems in competing the requirement if the technical data package approach is to be used. The developer may be willing to release the technical data rights, but at an unreasonable price that the Government cannot justify.

c. Affect on System

(1) Configuration. Configuration control involves the systematic evaluation, coordination, and approval or disapproval of proposed changes to the design and construction of

an item whose configuration has been formally approved [Ref. 21: p. 40]. When modifying the requirement so that sources will continue production or become willing to commence production, configuration changes will have to be considered. Also, configuration changes may be unintentionally implemented if the winning contractor misinterprets the requirement.

(2) Test Equipment. An IC produced for the military must "survive a punishing set of military screening requirements, then a second set of incoming tests when it arrives at the factories of most military prime contractors" [Ref. 10: p. 53]. Modifications to screening requirements and specification changes may limit the usefulness of currently used test equipment. Consequently, it may be necessary to develop or procure new test equipment to accommodate the component modifications.

(3) ILS Support. Macaruso states that the product aging cycle creates headaches for logistics managers who maintain military electronics systems. "Since the military demand cycle is often out of sync with the product life cycle . . . the DoD often needs a chip after it has disappeared from the commercial market" [Ref. 10:p. 51]. These headaches will be intensified by modifications intended to encourage other vendors to compete for the requirement because logistics managers will be responsible for supporting the newly designed system as well as the original system.

d. Other Considerations

(1) Availability of Specialty House. If the component is carried by a specialty house, the most feasible short-term action may be to buy a specified quantity to allow time to consider longer-term solutions. The quantity onhand at the specialty house, as well as the existence of other buyers must be ascertained in order to know how long the supply will last. There will not be a warranty if the specialty house does not manufacture the item, and it may be impossible to ascertain the reliability of purchased components without testing each one individually.

(2) In-House Production. The existence of GOGOs, GOCOs, and prime contractor fabrication capabilities should be investigated as well as the feasibility of setting up specialized Government or contractor production facilities. These facilities could be regarded as either short- or long-term solutions to the problem. As a short-term solution, production could be terminated when efforts to redesign the subsystem to accommodate current technology have been completed. As a long-term solution, the use of Government-funded production facilities will impede the component's inevitable decline into obsolescence. Since this alternative is usually costly and ensures a permanent supply of certain obsolete components, the contracting officer must ensure that the design is stable and that the components will be needed in sufficient quantity and for a long enough period of time to justify the expense and use of the facilities for this particular purpose.

(3) Time. The time period between notification and actual production shutdown will influence the method used to search for other sources as well as the decision whether or not to use in-house production capabilities. It may be possible to convince the source to extend the time period until alternatives can be fully investigated. Alternatives which take the least amount of time are continuation with the same source at an increased price and the prime contractor's search for other sources. If the original source agrees to continue production, negotiation of the additional compensation could be quickly accomplished. If modifications to screening requirements are involved, lengthy research and configuration approval processes may be involved. The prime contractor's search for other sources will proceed more quickly than a Governmental search because the prime contractor can rely upon knowledge of the industry and pre-established relationships with potential sources whereas the Government is restricted to formally advertised procedures. The in-house production alternative may be the most time-consuming of all since feasibility research and the modification or construction of production facilities must be accomplished.

(4) Cost. Consideration of costs to be incurred as a result of the source selection decisions depends to a large extent upon the nature of the particular alternative and the combination of actions required. For example, continuation with the same source may simply involve additional monetary

incentive, or it could involve costs associated with modifications necessary to influence the vendor to continue production. Modification costs will include changes to test equipment which may have to be redesigned to accommodate the component modifications, the cost of publications changes to document configuration changes, and recurring and nonrecurring costs associated with the actual modification. Qualification costs are usually necessary when another source is selected, and nonrecurring costs as well as qualification costs are involved with developing a new source, especially if the new source designs the required component. Use of competition may require the procurement of proprietary data rights, and the costs of in-house production capability could range from modification of existing facilities to complete construction of new facilities.

4. Advantages and Disadvantages

The advantages of seeking to maintain the same source or of finding other sources include:

a. Continuation with the same or slightly modified technology,

b. Allowing time to prepare for a long-range solution (i.e., redesign, development of in-house or commercial production capability).

The disadvantages include:

a. Cost of financially incentivizing the existing source,

b. Nonrecurring costs and qualification expense involved with selecting a new source,

c. The availability and cost of proprietary data rights,

d. Contract specification difficulties due to uncertain component composition, and/or outdated or non-existent data packages,

e. Possibility of intentional or unintentional configuration changes.

C. ENGINEERING SOLUTIONS

1. Identification

a. Substitution

The attempt to replace the obsolete component with one which performs the same or similar function.

b. Emulation

Process of producing electronic items which will perform the same function as the discontinued item with the same form and fit [Ref. 22]. There are several types of emulation. The first concerns the development of a new integrated circuit device that can be mask-programmable to replace the obsolete function in technologically obsolete devices. Another type of emulation involves redesigning and replacing obsolete components on one printed wiring board with a new board containing components with new technologies so that the second board is form, fit and functionally identical to the first. A third type of emulation involves hybrid microcircuit technologies to be used to provide form, fit and function replacement parts [Ref. 2:p. 17].

c. Redesign

Changing the design of either the obsolete component or the subsystem with which it interfaces to allow the introduction of technology considered more enduring than the obsolete technology. For the purposes of this research, the term "redesign" will refer only to subsystem redesign, since component

redesign essentially resolves the obsolescence problems by introducing new technology and requires the adaptation of system interfaces to the design.

2. Discussion

Configuration control involves the systematic approval or disapproval of proposed changes to the design and construction of an item whose configuration has been formally approved [Ref. 21:p. 40]. Analysts seeking a solution to the obsolescence problem want to cause as little disruption to the affected system as possible. Therefore, the thought processes involved in an analysis of engineering solutions progress logically from changes which least affect system configuration to those which most affect configuration. Methods of resolving the obsolescence problem having the least affect on configuration include substitution and emulation. Engineering personnel interviewed at NAVAIR and Grumman concur that the first engineering reaction to an obsolescence problem is to investigate possible component substitutes. If no substitute is available, emulation might be considered next [Ref. 2:p. 17]. Though an intriguing and promising idea, NAC personnel acknowledge that avionics emulation has not been used with any substantial amount of success to date [Ref. 13]. NAC resources are available to assist with identifying substitutes for microelectronic components or determining the feasibility of emulation. The Navy Program Manager's Guide lists Navy-sponsored research laboratories, areas of research concentration, and procedures for tasking the laboratories to assist with particular problems [Ref. 23:pp. 2-18].

If substitutes cannot be found and emulation is not technically or economically feasible, redesign to accommodate newer technology becomes a viable technical alternative to consider. Redesign will affect configuration and requires formalized documentation. Accounting for configuration changes is accomplished through the use of Engineering Change Proposals (ECP). There are two types of ECPs: Class I and Class II. An engineering change is classified as Class I when there is an effect on the functional configuration identification, the product configuration identification as contractually specified, and/or technical requirements contained in the product configuration identification. These technical requirements include performance outside stated tolerance, interface characteristics , and reliability, maintainability, and survivability outside stated tolerance. [Ref. 21:p. 44] A more complete listing of the elements within Class I classification categories can be found in Hallums [Ref. 21:pp. 44-45]. An engineering change is classified as Class II when it does not fall within the definition of a Class I change. Examples include a change in documentation (correction of errors, addition of clarifying notes), and a change in hardware (substitution of an alternative material) which does not affect the factors listed under Class I. [Ref. 21:p. 45]

NAVAIR personnel interviewed stated that Class II changes can be made at the contractor level, are relatively inexpensive, and the least disruptive to overall system considerations. A

Class I change, on the other hand, involves significant expense, impacts configuration dramatically, and is time-consuming to approve and implement. [Ref. 16]

3. <u>Factors to be Considered</u>

Factors applicable to the analysis of engineering solutions are identical to those involved with source solution decisions because a relevant option in source solution analysis involves modification of the component's or subsystem's characteristics to maintain or stimulate interest in the production of obsolete technology. However, alternatives within the engineering solutions category are less sensitive to manipulative tactics than those within the source solution category. For example, the source solution alternatives can be made viable by financially motivating manufacturers to produce obsolete technology, relaxing screening requirements, or implementing amenable modifications, whereas, in the case of engineering alternatives, a substitute is or is not available and emulation is or is not feasible. There is no way to change these basic technological limitations. Consequently, the factors have been divided into two sections:

a. Limitations upon Alternatives

(1) quantity

(2) design stability

(3) duration of production

(4) complexity of system

(5) composition of components

(6) proprietary data rights

(7) time

(8) cost

b. Effect on System

(1) configuration

(2) test equipment

(3) ILS support

Factors included in the first section represent limitations imposed upon particular engineering alternatives due to the nature of the component or situation. Effects upon the system and support environment are included in the second section. Since the choice of a specific engineering alternative is fairly rigidly controlled by circumstance, the applicability of particular factors to the most relevant alternatives will be discussed in narrative format under the appropriate heading.

a. Limitations upon Solutions

As noted previously, the technology relevant to this discussion is limited by the scope of this research to mature technology which is rapidly phasing into old technology. At the point in time when analysis of various available alternatives commences, one source still exists and other sources have just recently phased-out production of the affected component's technology to concentrate on state-of-the-art pursuits. Impressions derived from interviews are that the existence of one remaining source and the fairly recent participation of other sources in the production of the obsolete technology provides

more opportunities to identify substitutes or to develop emulation capabilities than if old technology were involved.

The availability of substitutes will depend upon the complexity of the system and component composition. The more complex the system or varied the component composition, the more likely that a substitute will not be found to match the required function, or emulation will not be technologically possible since there will be too many design and performance variables [Ref. 16]. It may be necessary to purchase proprietary data rights to determine the actual component composition. Emulation will prove particularly costly and time-consuming if techniques must be developed for individual applications.

According to the NAC obsolescence brochure, redesign of the subsystem to accommodate new technology should be the last alternative selected after attempts to find substitutes have failed and emulation has been determined technologically or economically not feasible [Ref. 2:p. 17]. The reasons are that redesign is time-consuming, costly and affects the system configuration. Before deciding to redesign, long-range system plans such as quantities required, duration of production, and design stability must be considered. If the system design is stable and expected to be in production for the foreseeable future, substitutes are not available, and emulation is not feasible, redesign may be the only option which will guarantee the perpetuation of the system.

The time available before production shutdown will influence the amount of research effort which can be accomplished.

A check for the availability of substitutes can be performed relatively quickly compared to the time it will take to emulate or redesign the component or subsystem. Cost will depend upon the alternative chosen and the combination of actions required. In general, substitution will be the least costly since the substituted component will interface with the same subsystem as the obsolete component, and redesign of the subsystem will be the most expensive since interfaces and publication changes are affected. The cost of emulation varies with the chosen application and availability of techniques but emulation through redesign is considered "too costly to serve as a new source of discontinued parts" [Ref. 5:p. 43].

b. Effects on Systems

Initial attempts to use substitution and emulation are motivated by the desire to disrupt system configuration as little as possible. Progression from substitution and emulation solutions requiring no interface modifications, to the need for slight interface modifications to full-fledged subsystem redesign to accommodate new technology results in increasingly major effects upon system configuration. Requirements for configuration change approval, publication changes, and the adaption of system test equipment to interface with the redesigned subsystem must be met, and logistics support becomes increasingly complex. If the decision is made to retrofit the change, plans must be made to change the designs of all existing subsystems. A decision to forward fit the change will

result in the need to support the subsystems currently operational as well as the subsystems incorporating the design change. [Ref. 15]

#### 4. Advantages and Disadvantages

The advantages to engineering solutions include:

a. Continuation with existing subsystem configuration if use substitution or emulation,

b. Redesign will result in the development of a system using more enduring technology than the replaced obsolete technology.

The disadvantages include:

a. Configuration changes to component when substitution or emulation are used, and configuration changes to the subsystem when redesign is implemented to accommodate different technology,

b. Costs of emulation and redesign,

c. Time it takes to emulate or redesign may cause problems with production line continuity.

### D. SUMMARY

Categories discussed and analyzed in this chapter have been identified as Source Solutions and Engineering Solutions. They have been grouped into one chapter because most of the alternatives within both categories are initially analyzed and sometimes resolved at the contractor level. For example, the decisions to continue with the existing source, find another source, identify a suitable substitute or initiate a Class II engineering change are often made by the prime contractor. Other alternatives are significantly analyzed at the contractor level prior to elevation to the program manager. The next

chapter will focus upon categories of alternatives whose nature forces immediate elevation to the Governmental level.

# V. DISCUSSION OF ALTERNATIVES: SYSTEM SOLUTIONS AND STOCKPILE SOLUTIONS

## A. INTRODUCTION

This chapter is intended to discuss and analyze the system and stockpile solutions to the obsolescence problem created when the last known source for a particular component plans to cease production. Each solution category is divided into four sections: Identification, Discussion, Factors of Consideration, and Advantages and Disadvantages. Though initially considered at the prime contractor level, alternatives within each solution category are ultimately resolvable at the Government level. System solutions require the use of Government assets, and stockpile solutions rely upon the availability of Government funds.

## B. SYSTEM SOLUTIONS

### 1. Identification

#### a. Cannibalization

In the context of this research, cannibalization is the process of taking components or subsystems needed for production from an existing system with the intention of using the cannibalized items to prevent production line shutdown.

#### b. Navy Supply System

When a weapon system is placed into operation, provisioning and inventory controlling mechanisms within the supply system ensure that an appropriate number of system spare

parts will be onhand to support the system during its life. Production requirements are satisfied separately through contractual arrangements with vendors. The Navy supply system alternative involves using supply system assets to support production requirements.

2. Discussion

When faced with an impending obsolescence problem and a very short timeframe within which to react, the options of cannibalization or using the supply system assets may appear attractive. If the urgency of the situation is such that virtually no time exists to explore other alternatives and the production line is in imminent danger of shutting do without the required component, there is justification in investigating the use of these alternatives [Ref. 15]. However, personnel interviewed stress that these two solutions do not solve the problem satisfactorily and are useful only as very short-term solutions until thorough analysis can be performed to determine a more permanent resolution to the problem.

3. Factors to be Considered

Since system solutions are considered of short-term benefit and are selected quickly to satisfy an impending crisis situation, factors considered prior to making the decisions are relatively basic. The following three factors should be examined prior to taking cannibalization or system solution action:

a. Time before production is affected. If there is a distinct possibility that the weapon system production line processes will halt or be severely constrained

without the obsolete component, locating and acquiring a sufficient quantity of components may be the fastest way to prevent this occurrence. Satisfaction of immediate production requirements will allow time to consider more permanent alternatives.

b. Availability of components in supply system. System stock must be checked to ascertain if the required component is carried in the supply system. Problems may be encountered from system stock managers who will want to analyze the effect of reduced stock levels on projected fleet support requirements.

c. Availability of systems to cannibalize. The term "cannibalization" is generally construed to mean cannibalizing parts from the same organizational unit's assets [Ref. 15]. Locating systems to cannibalize may result in consideration of inoperable units placed in long-term storage, or units not under specific organizational control. In the past, parts have been taken from Naval Air Rework Facilities' (NARFs) disassembled aircraft inventories, and replaced before aircraft are reassembled.

Cannibalization and the utilization of system assets are not normal procedures taken to satisfy production requirements. Consequently, there are no formalized procedures for taking this course of action. [Ref. 15] The program manager must call upon "behind the scenes" management skills to accomplish either of these actions. Arrangements for component payback will inevitably be involved.

4. Advantages and Disadvantages

The advantages to using cannibalization or system assets include:

a. Almost immediate access to urgently required components,

b. Assurance that production line processes will continue until longer range solutions can be investigated.

Disadvantages include:

a. The fact that these solutions are short-term and do not materially contribute to the resolution of the obsolescence problem,

b. Possible negative effect on the supply support system by significantly reducing assets intended for fleet usage,

c. Possible negative effect on fleet readiness by cannibalizing components necessary for operational availability.

## C. STOCKPILE SOLUTIONS

### 1. Identification

A life-of-type buy is the one-time purchase of enough items to completely support the weapon system for the remaining life of the system. It is more commonly referred to as a "buyout" [Ref. 24:p. 1]. For the purposes of this research, three types of buyout are considered: buy all anticipated production requirements, buy enough items to sustain production until the system is redesigned, and purchase the semi-finished product with the intention of contracting for final assembly as needed.

### 2. Discussion

It is the policy of the Department of Defense that a life-of-type buy for a "quantity of secondary items no longer to be produced shall be made only when all other more economical alternatives to a material shortage or manufacturing phaseout have been exhausted" [Ref. 24:p. 1]. Interviewees stated that reasons for this policy can readily be seen from noting problems faced concerning buyouts for production line support. These include the following items.

#### a. Estimated Quantities

> The DoD as a whole has not demonstrated a consistent capability for accurately determining life-of-type buy requirements within the time limits imposed by manufacturers' phase-out decisions. . . . Contributing factors include the lack of comprehensive end item application data and the difficulty in predicting equipment life. [Ref. 17: p. 5]

Estimating production requirements is based primarily upon the Five Year Defense Plan (FYDP). With the exception of multi-year procurement, firm contracts for requirements are annual so exact quantities are known only on an annual basis. For these reasons, estimating how much to buy to satisfy production requirements for a system cannot be exact and this potential for waste is cited as a reason for analysts to seek other more cost-effective solutions. [Ref. 24:p. 2]

b. Government Furnished Materials (GFM) and Storage

To avoid the overhead added to buyout quantities when the prime contractor purchases the quantities through several tiers of subcontractors, the Government may decide to "breakout" the component from the contract and directly buy out the manufacturer. This action eliminates Government reliance upon the contractor to manage the routine elements of providing production support components, and generates management, storage and warranty problems for the Government. For example, the GFM must be provided to the contractor in guaranteed working condition at the right time and to the right place. Since quantities may need to be stored for several years prior to use, it may be difficult to ensure that the components are good. Storage of microcircuits may create problems if controlled environments are required. [Ref. 25]

c. Funding

Funding procedures for life-of-type buys are described in the DoD instruction concerning life-of-type buys and

require that the integrated material manager (IMM) fund the portion of the buy required for initial spares for replenishment stockage for the life of the item, and the end item program manager fund the portion of the buy to be used as government-furnished material (GFM) for new production of end items. The end item program manager passes the funded requirement to the IMM who includes these requirements in the system life-of-type buy. [Ref. 24:p. 2] The basic problem with this procedure is that the program manager will not have funds specifically available for life-of-type buys because obsolescence problems are unfunded. Budgeting for obsolescence problems would be an admission that the potential problems were not foreseen in the design phase.

> The optimal point for addressing the problem is in the equipment design stage. . . . The use of "preferred for new design" parts and standard electronic functions constitutes the most viable approach to avoiding obsolescence problems by limiting the variety of electronic part styles and types. [Ref. 7:p. 6]

Telephone interviews with Naval Supply Systems Command (NAVSUP) management personnel revealed no sympathy for the obsolescence predicament they believe could have been planned for during the system design phase [Ref. 26].

d. Prime Contractor Buyout

> Many manufacturers give six months advance notice when a product or product line will be discontinued . . . . Research required to determine a means of support, along with a cost analysis, cannot always be compressed into this timeframe. [Ref. 17:p. 69]

Procedures discussed in Chapter III require that the prime contractor analyze the situation internally and present

recommendations to the program manager. The program manager ensures that contracting, logistics and technical personnel consider all available information and determine the course of action to be taken. Interviews with NAVAIR and Grumman personnel have indicated that if the program manager's decision is not given to the prime contractor prior to the buyout date, the prime will react to protect the production line by buying estimated quantities required for projected production requirements and then request reimbursement from the Government. Usually, the prime contractor will plan for the funding to be covered in subsequent contracts; however, a change in Governmental requirements may leave the prime with excess quantities onhand.

Buyout for production support is a particularly fertile area for the Government and the prime contractor to face conflict over established obsolescence policies. This conflict is generated if the timeframe provided by the manufacturer between notification and final buyout opportunity is narrow. This section will focus upon production support problems related to buyout by providing two examples when the prime contractor bought out the manufacturer prior to receipt of Government authorization. An example showing cooperation between the Government and the contractor to resolve the problem will conclude the section.

(1) Example 1: Teledyne Systems Company. This example is intended to illustrate why the prime contractor felt the need to buy out the manufacturer prior to Government

authorization, how the requirements were estimated, how the prime contractor expected to cover the costs internally, why the Government ended up reimbursing the prime contractor, and specific problems which concerned the Government during the reimbursement negotiations.

In 1984 Teledyne Systems Company notified Grumman that Motorola, a lower-tier contractor, would cease production of MSI dice needed to support Computer Signal Data Converter (CSDC) production fo the F-14A. Grumman notified NAVAIR of the problem, and ASO was also alerted by Teledyne. Grumman commenced an in-house analysis of alternatives and considered:

a. Procurement of MSI dice through alternate sources,

b. Replacement of MSI dice with equivalent parts,

c. End-of-life procurement from Motorola, either by Grumman or Teledyne.

Grumman internal memoranda stressed the need for more time to thoroughly analyze the alternatives, but stated that enough research was conducted to make the decision that the EOL buy was the most practical approach.

Not having received authorization from NAVAIR, and concerned with the obligation to stockholders to ensure production line continuity, Grumman authorized Teledyne to buy anticipated FY 86 through FY 89 requirements. The Five Year Defense Plan (FYDP) was used to estimate the quantities required. Grumman incurred a $2 million termination liability which was expected to be reduced upon receipt of the FY 86 F-14 Advance

Acquisition Contract. In this case, Government reimbursement would not have to be separately funded, but could be included in subsequent contracts. However, the number of F-14As required was subsequently reduced, and Grumman was left with more components in inventory than would be needed to satisfy production requirements. Faced with a request to reimburse Grumman for the entire amount, Government negotiators were reluctant to reimburse the entire amount since Grumman's buyout action had not been authorized by the program manager. The Government preferred to pay for the MSI dice as they were used. Final settlement of the issue resulted in Grumman being reimbursed for the entire amount, and the excess components placed into the Navy supply system. The action was considered to be in the best interest of the Government.

(2) Example 2: Sundstrand Data Control, Inc. This example provides an instance when estimates of the buyout quantity cannot be used because production lot size dictates the actual quantity to be procured, shows how overhead applied by subtier contractors affects the ultimate price, and concludes with total Government reimbursement.

In this case, the manufacturer forced the subtier contractor to buy a quantity which exceeded foreseen production requirements because the units had to be produced in a particular lot size. Sundstrand Data Control, Inc., bought 1,200 integrated circuits from Signetics when only 200 were needed. The $15 original unit price had $41 Sundstrand overhead

added when purchased by Grumman. Again, the Government originally negotiated to pay for the components as they are used, but eventually agreed to fund the entire amount.

The resolution of the funding problems in the examples cited above leaves the Government with several unique considerations regarding contractual arrangements. When the Government agrees to reimburse the contractor for the buyout quantity, contractual arrangements concerning warranty of GFM involve the prime contractor becoming the overseer of the Government bonded warehouse where the units are stored. The warranty obligation is assumed by the prime contractor. In this manner, the Government is not bound by the customary GFM storage, delivery and warranty obligations. [Ref. 25]

(3) <u>Example 3: Purchase of Semi-Finished Product</u>. This example illustrates cooperative efforts among Government, contractor, and supplier personnel to resolve an impending obsolescence problem. The supplier was persuaded to extend the shutdown date so that sufficient time would be available to analyze alternatives, and a relatively unique solution was proposed and implemented as a result of the extensive analysis and cooperation. It was decided to buy the semi-finished products, store them for future need, and then contract for the assembly of the finished product when needed.

In 1983, a supplier informed Grumman 6-8 months in advance of plans to stop producing a particular microchip. It was estimated that an engineering change would

cost $20 million, and a decision to buy and store the finished product was determined to be too expensive since estimates of future use were uncertain. The decision to buy the wafers, a circular board containing hundreds of identical dice, and store them in a sealed, dry nitrogen, high security, blast proof storage vault at NAC took over a year. One of the more unique contracting problems encountered concerned estimating the yield for each wafer. Yield had to be considered from cutting up the wafer, moving the dice to the integrated circuit, and moving the integrated circuit t che board. The contractor extended the shutdown date to accommodate the decision after noting the extensive effort being taken to resolve the problem. Now, once a year, a year's worth of production supply and spares wafers are sent to Ge.ieral Ins-ruments for subcontractor assembly. NAC has expanded its wafer storage to storing wafers for ASO, NAVSEA, and the Army.

3. Factors to be Considered

Buyout is used to procure enough components to last for the life of the system or to sustain production until redesign can be accomplished. Factors to consider in making the "within category" analysis are grouped as follows:

a. System Stability

(1) stability of design

(2) duration of production

(3) quantity

(4) complexity of system

b. Material Considerations

(1) shelf-life

(2) storage

(3) composition of components

(4) proprietary data rights

c. Other Considerations

(1) time

(2) cost

Factors discussed in the first section have previously been included as decision factors in source solution and engineering solution analyses, and relate specifically to aspects of the system which must be considered before the buyout option is chosen. The nature of the buyout procedure necessitates the inclusion of the second section entitled, "Material Considerations," which is oriented toward purchase, storage and warranty problems, and cost and time are included in the third section as additional relevant decision factors. The "Effect on System" section included in previous analyses is omitted because the purpose of the buyout procedure is to preserve the system in its current state. The only effect on the system may be the logistics problems of storing and delivering the buyout quantities, and these aspects will be discussed in the second section.

a. System Stability

(1) Stability of Design and Duration of Production. These factors relate to the length of time the existing design is expected to be used, and the time period over which the system

utilizing the affected component is to be produced. The objective of the buyout alternative is to provide the required number of components for the time period needed. Plans to redesign the subsystem or replace the affected component with a new design will affect the amount of time the buyout quantity will be useful, as well as the planned length of production for the system.

(2) Quantity. The determination of an accurate buyout quantity will depend upon the time period over which the components will be used. Plans to redesign the subsystem or to replace the component with a new design must include implementation dates so that buyout quantities intended to sustain the system until the change is completed may be accurately estimated. Estimating quantities for a lifetime buyout will be hindered by the lack of firm plans to continue producing the system beyond the projections contained in the FYDP. Even when it is possible to attain a reasonable estimate of required quantities, the manufacturer may be unwilling to produce the exact amount due to lot size requirements or a perceived uneconomical production run.

(3) Complexity. If the component is considered complex, system designers may be influenced to buy a life-time supply rather than disrupt the component and subsystem designs with increasingly intricate changes. Complexity will also affect quantity estimation procedures. A larger percentage of expected nonworking components will have to be included in the estimates.

b. Material Considerations

(1) Shelf-life and Storage. Buying a sufficient quantity of material to last for the estimated production period may necessitate storing the components or unpackaged devices for an extensive period of time. The length of time that these components can be expected to remain operable, as well as the need for a controlled storage environment must be considered. If arrangements are not made to store the components at the contractor facility, the Government will be responsible for delivering operable components as required. The storage of unpackaged devices will require the establishment of a contract for periodic assembly and delivery.

(2) Component Composition and Proprietary Data Rights. Knowledge of the component composition will assist with the determination of shelf-life and storage considerations. Purchase of proprietary data rights may be necessary to find out component composition.

c. Other Considerations

(1) Time. This factor refers to the length of time available between notification of impending production shutdown and the "last buy" date. The amount of time available to decide upon a course of action will influence the analysis to determine whether buy out until redesign, life-time buy or the purchase of unpackaged devices is the most feasible approach. Time will also influence the accuracy of the quantity estimates.

(2) Cost. If the prime contractor makes the life-time buy through subcontractor tiers, the cost will include

the actual cost of the component plus added overhead at each tier. Additional costs are storage, purchase of too many components due to mandated production lot sizes or FYDP changes to defense requirements, and the price of warranties and/or proprietary data rights. The purchase of unpackaged devices will require subsequent assembly charges.

4. Advantages and Disadvantages

The advantages of buyout include:

a. Expediency of quickly procuring enough items to preclude the possibility of production line shutdown,

b. Capability of continuing the same configuration.

The disadvantages of buyout include:

a. Difficulty in estimating exact quantities required for future production needs since contracts do not exist for future end-item requirements,

b. GFM storage and warranty problems when the Government purchases the items,

c. Prime contractor motivation to buy out the subcontractor prior to receiving Government authorization and then requesting reimbursement for the entire quantity,

d. Obtaining relief from GFM warranty requirements when the prime contractor buys out the vendor.

## D. SUMMARY

This chapter concludes the discussion and analysis of the four categories of alternatives identified in Chapter IV. Each category has been discussed and analyzed separately, and factors considered particularly relevant to the analysis of "within category" alternatives have been identified and discussed. The following chapter will provide an approach for "between category" analysis.

## VI. COMPARISON AND SELECTION OF ALTERNATIVES

### A. INTRODUCTION

Four categories of alternatives to be considered in the resolution of the obsolescence problem as it relates to major system production were presented in the preceding two chapters. Within each category of alternatives, factors were identified to assist with the analysis of each alternative. The first part of this chapter summarizes the significant features of the "within category" decision process. The second part of this chapter identifies factors which are to be used in the analysis of alternatives "between categories." The chapter concludes with a decision model and example for its use.

### B. "WITHIN CATEGORY" FEATURES

Previous chapters have shown that "within category" analysis is primarily a process which moves logically from alternatives which least disrupt current procedures to those requiring progressively significant adjustment to procedures or configuration. For example, an analysis of the source solution alternatives initially considers continued use of the same source. If this is not possible, a search for another source is conducted--first by the contractor, and then by the Government. The availability of specialty house assets and in-house Government or contractor manufacturing capability is assessed, and the

final recourse is to develop another source or in-house production capability. The relative feasibility of each alternative can be manipulated by offering the original contractor more money, modifying requirements to attract other manufacturers, or relaxing specifications. In contrast, the engineering solutions are more rigidly limited by technical qualifications. As substitution, emulation and redesign are investigated, they must be accepted or rejected based upon technological feasibility. System solutions provide another example of alternatives which are either possible or not possible, depending upon the availability of components within the supply system or the existence of systems potentially available for cannibalization. Stockpile decisions are dependent upon the situation, and include buying a small quantity until redesign is accomplished, purchasing the entire quantity needed for the anticipated production life-time, or buying the semi-finished product. Table 1 provides a summary of "within category" alternatives.

Factors represent circumstances existing at the time the obsolescence problem occurs which will influence the choice of "within category" alternatives. For example, the willingness of the original supplier to continue production, or the availability of a substitute makes both of these alternatives feasible options. A combination of circumstances further guides the selection of particular alternatives within each category. For example, a short time-frame within which to make the decision, impending plans for a design change, and a highly complex

TABLE 1

"WITHIN CATEGORY" ALTERNATIVES

| Source | Engineering | System | Stockpile |
| --- | --- | --- | --- |
| Original Producer | Substitute | Supply System | Buyout Production Life-Time Quantity |
| Contractor Find Another Source | Emulate | Cannibalize | Buyout Until Redesign |
| Government Find Another Source | | | |
| Develop New Source | Redesign | | Buy Semi-Finished Product |
| Specialty House | | | |
| In-House Production | | | |

Source: Developed by researcher

component will cause the "buyout until redesign" option to look very attractive.

C. DISCUSSION OF "BETWEEN CATEGORY" FACTORS

The use of "within category" alternative analysis may result in the selection of one or more feasible solutions from each category. However, a method is also needed in order to make a "between category" selection. This section identifies and discusses five factors which directly influence the choice of an alternative both within and between each category. These factors are: (1) time, (2) stability, (3) cost, (4) quantity, and (5) complexity. As will be seen in the subsequent analysis, these five factors incorporate all of the factors discussed in

Chapters IV and V, except the specialized factors related to the "supply system" and "cannibalization" alternatives. Each factor is defined, and alternatives which are most likely to be chosen due to particular characteristics of the factor are weighted. To avoid obscuring the following presentation, only two characteristics have been identified for each factor. For example, time is either short or long, a system is either stable or not stable. The (+) weight indicates that the alternative will be chosen if the particular factor characteristic exists, and the (-) indicates that the alternative will not be chosen if the characteristic exists. The (0) implies that the alternative may or may not be chosen. The decision model combines the five factors and the alternatives into a matrix in which each alternative can be assessed based upon the (+), (-) and (0) weighting indicators.

Table 2 illustrates the completed matrix. The assignment of weights is based upon the researcher's analysis of interviews and written material presented in Chapters IV and V of this study. The discussion which follows explains why particular weights have been chosen for each alternative/factor relationship. Clarifying examples are presented to facilitate assignment of weights. Though it is acknowledged that actual situations may be much more complex than those presented below, the relative simplicity is necessary to illustrate the basic mechanics of the decision model. Qualifying explanations are provided to indicate that different circumstances could result

TABLE 2

ALTERNATIVES WEIGHTED IN RELATION TO APPLICABLE FACTORS

| | TIME | | STABILITY | | COST | | QUANTITY | | COMPLEXITY | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Short | Long | Stable | Not Stable | Low | High | Small | Large | Not Cpx. | Complex |
| Original Producer | + | 0 | + | + | + | - | + | + | + | + |
| Contractor Find Another Source | + | 0 | + | - | + | + | 0 | + | + | 0 |
| Government Find Another Source | - | + | + | - | 0 | + | - | + | + | 0 |
| Develop New Source | - | + | + | - | - | + | - | + | + | 0 |
| Specialty House | + | 0 | + | - | + | - | + | 0 | + | + |
| In-House Production | - | + | + | - | - | + | - | + | + | 0 |
| Substitute | + | 0 | + | - | + | - | 0 | + | + | + |
| Emulate | - | + | + | - | - | + | - | + | + | 0 |
| Redesign | - | + | N/A | N/A | - | + | - | + | 0 | + |
| Supply System | + | - | - | + | + | - | + | - | + | 0 |
| Cannibalize | + | - | - | + | + | - | + | - | + | 0 |
| Buy Out Production Life-time Quantly | + | 0 | + | - | - | + | - | + | 0 | + |
| Buy Out Until Redssign | + | 0 | - | + | + | 0 | + | 0 | 0 | + |
| Buy Semi-Finished Product | 0 | + | + | - | + | 0 | - | + | + | 0 |

Source: Developed by researcher

in reclassification. Little comment is provided if the weight assignment is evident based upon the discussion and factor sections of Chapters IV and V of this study.

1. Time

The manufacturer's announcement of impending production shutdown includes a time period between customer notification and the "last buy" date. The length of this period will influence the time available to conduct an analysis of the situation, consider all possible alternatives, and select and implement the alternative. The time for which the selected alternative will be useful is considered under the "stability" factor.

If the time period is relatively short (less than two months), alternatives will be chosen which can be implemented rapidly. These will consist of options in which the product is already available, or can be modified and produced quickly. Alternatives with a (+) indicator include:

(1) Original Producer,

(2) Contractor Find Another Source.

Convincing the original supplier to continue production could be accomplished quickly if additional compensation is all that is required. Contract modification or the relaxation of specifications may require more time. If the prime contractor has originated the specifications, modifications could be specifically targeted toward potential suppliers. The prime contractor may also be able to rapidly find other sources

because of extensive knowledge of the industry, and existing contractual relationships.

(3) Specialty House,

(4) Substitute,

(5) Supply System,

(6) Cannibalize.

Components are potentially immediately available with each of these alternatives. Problems may be encountered with insufficient quantities, or the reluctance of asset managers to allow fleet support components to be used for production.

(7) Buyout Life-Time Production Quantity,

(8) Buyout Until Redesign.

These alternatives can be implemented immediately because the manufacturer usually offers one "last buy" opportunity. However, the decision to buyout until redesign, or buyout to end of production requires time to accurately estimate required quantities.

If the time period is long, alternatives may be chosen which will allow time to compete the requirement, set-up production facilities, emulate, or redesign the subsystem. The (+) alternatives include:

(1) Government Find Another Source,

(2) Develop New Source,

(3) In-House Production,

(4) Emulate,

(5) Redesign,

(6) Buy Semi-Finished Product.

The two (-) alternatives, "supply system" and "cannibalization," are not considered desirable solutions and are never chosen if time is sufficient to allow the exploration of other alternatives. The (0) alternatives, "original producer," "contractor find another source," "specialty house," and "substitution" are not excluded from selection; however, the long time period enables the additional consideration of the above-listed alternatives. This would not be practical if sufficient time was not available to implement the alternatives.

2. Stability of Design

For the purposes of this analysis, stability involves the amount of time production will continue without changing the system design. It includes the "duration of production" factor described in Chapters IV and V. If the system design is considered stable, alternatives may be considered which will represent long-range solutions to the problem. These (+) alternatives include:

(1) Original Producer,

(2) Contractor Find Another Source,

(3) Government Find Another Source,

(4) Develop New Source,

(5) Specialty House,

(6) In-House Production,

(7) Substitute,

(8) Emulate,

(9) Buyout Production Life-time Quantity,

(10) Buy Semi-Finished Product.

Using the same component, finding a substitute, buying a sufficient quantity to last for the life of production, or emulating the integrated circuit's form, fit, and function are all solutions intended to allow the system to continue unchanged. Developing a new source or in-house production capability, and arranging for emulation imply serious interest in sustaining the technology beyond its normal period of decline.

The system will be considered not stable if there are plans to stop system production or to redesign the component or subsystem. In this case, short-term solutions will be preferred:

(1) Original Producer.

This alternative is a short- or long-term solution. The original supplier could be convinced to extend production until other alternatives can be considered, or to agree to continue providing required quantities indefinitely.

(2) Cannibalize,

(3) Supply System,

(4) Buyout until Redesign.

The (-) alternatives represent options which are taken to sustain the system. If the system will not be in production much longer, or the component or subsystem is to be redesigned, these alternatives would not be practical.

3. <u>Cost</u>

This factor includes all costs typically associated with each alternative and includes integrated logistics support, test equipment and configuration change factors discussed in Chapter IV. Since obsolescence is unfunded, consideration must be given to whether a low or high cost solution is involved. The need to continue supplying the item for an anticipated lengthy production life may justify a greater investment than the need to use the component for a relatively short time period. Generally, a low cost solution will include the following (+) alternatives:

(1) Original Producer,

(2) Contractor Find Another Source.

These alternatives allow procedures to continue virtually unchanged. The only costs might include additional compensation, and costs associated with modifications.

(3) Specialty House.

This option allows the purchase of the item "off-the-shelf" with no layered overhead.

(4) Substitute,

(5) Supply System,

(6) Cannibalization,

(7) Buyout Until Redesign,

(8) Buy Semi-Finished Product.

The (-) alternatives, "develop new source," "in-house production," "emulate," "redesign," and "buyout production life-time quantity" are never considered low cost options.

"Government find another source" is either a low or high cost alternative, depending upon the nature of the costs involved.

A high cost solution will be considered feasible if plans are to continue using the component for an indefinite period of time, or if no recourse exists but to redesign to accommodate different technology. Alternatives include:

(1) Contractor Find Another Source,

(2) Government Find Another Source.

Costs may involve the acquisition of proprietary data rights, changing specifications, different test equipment, qualifying new source, purchasing warranties, and other similar costs.

(3) Develop Source,

(4) In-House Production,

(5) Emulate,

(6) Redesign,

(7) Buyout Production Life-Time Quantity.

The (-) indicates options which will not be chosen as high cost alternatives because they involve purchasing the same or similar items. The (0) alternatives, "buyout until redesign," and "buy semi-finished product," may or may not be chosen as high cost alternatives, depending upon the quantity required and the cost of each item.

4. <u>Quantity</u>

The quantity required will determine the amount of effort needed to resolve the problem. For instance, a small quantity may be needed if there are plans to redesign the

subsystem or to replace the component. In this case, short-term solutions are most appropriate, and the (+) alternatives include:

(1) Original Producer,

(2) Specialty House,

(3) Supply System,

(4) Cannibalize,

(5) Buyout Until Redesign.

The (-) alternatives will not be chosen because "Government find another source," "develop new source," "in-house production," "emulate," "redesign," "buyout production lifetime quantity," and "buy semi-finished product," are solutions implemented when the quantity is sufficient to justify expenditure of funds, effort and time. The (0) alternatives may or may not be chosen, depending upon the circumstances. For example, it may be relatively easy for the contractor to find another source or for a substitute to be located.

If the quantity is substantial, it will be sensible to either plan for a long-term supply of the items or to redesign the subsystem to avoid the problem. The (+) alternatives include:

(1) Original Producer.

This alternative is applicable as a long-term solution if the supplier can be convinced to continue production on a long-term basis. If the supplier is not willing to produce the item indefinitely, this alternative becomes short-term.

(2) Contractor Find Another Source,

(3) Government Find Another Source,

(4) Develop New Source,

(5) In-House Production,

(6) Substitute,

(7) Emulate

(8) Redesign,

(9) Buyout Production Life-Time Quantity,

(10) Buy Semi-Finished Product.

A continued need for large quantities justifies the exploration of all alternatives except the (-) options of using supply system assets or cannibalization. These are not considered acceptable permanent solutions to the problem. The (0) option, "specialty house," may or may not be chosen depending upon the amount of assets on hand and the ability of the specialty house source to continue providing the item. The other (0) alternative, "buyout until redesign," will only be considered if the quantity required before redesign is substantial.

5. Complexity

This factor also includes the factor, "component composition," previously discussed in Chapters IV and V, and involves problems encountered with attempts to successfully duplicate the component. If the component is not considered complex and all hybrid aspects of the item are identifiable, (+) alternatives may include those which strive to continue utiliz[illegible] the same or similar component. These include:

(1) Original Producer,

(2) Contractor Find Another Source,

(3) Government Find Another Source,

(4) Develop New Source,

(5) In-House Production,

(6) Specialty House,

(7) Substitute,

(8) Fmulate

(9) Supply System

(10) Cannibalize,

(11) Buy Semi-Finished Product.

If the component is not complex, modifications may be relatively simple to implement, specifications are less likely to be misunderstood by potential sources, similar items may be available, and remanufacture, emulation, or buying the semi-finished product for future assembly are more likely to be successful.

A complex component or subsystem could stimulate two courses of action. It may be considered desirable to continue with the existing or similar component to avoid the possibility of being unable to successfully duplicate the item. On the other hand, it may be prudent to obviate anticipated future problems by taking the opportunity provided by the obsolescence problem to redesign the component or subsystem. The (+) alternatives include:

(1) Original Producer,

(2) Specialty House,

(3) Substitute,

(4) Redesign

(5) Buyout Production Life-time Quantity,

(6) Buyout Until Redesign.

The use of the (0) alternatives, "contractor find another source," "Government find another source," "develop new source," "in-house production," and "emulation" is possible with complex components and subsystems. However, there is risk that the complexity will make it difficult to successfully implement these alternatives. "Supply system," or "cannibalization" may be chosen depending upon component availability in the system, and buying the semi-finished product is highly dependent upon characteristics of the component and the feasibility of assembly at a later date.

As is probably suspected, the process of weighting alternatives in relation to factors is far from definitive. A slight change in circumstance, or a more extensive definition of a particular alternative could easily result in reassignment of weights. Consequently, the generalized thought process outlined above can only serve as a guideline for the weighting of specific alternatives based upon an actual situation.

D. DECISION MODEL

During the course of this research, alternatives have been grouped into four categories. Two of the three phases for the selection of feasible alternatives to resolve the obsolescence problem have been presented. The first phase demonstrated

that logical thought processes and the existence of particular circumstances largely dictate the choice of feasible alternatives within each category. Relevant factors were used to analyze the alternatives within each category. The second phase identified factors which were perceived to be common to all categories, and offered a method for weighting the alternatives in relation to the factors.

The third and final phase provides a methodology for selecting alternatives which are most likely to remain as feasible solutions after all circumstances existing in a particular situation are considered. The weight assignments from Table 2 will be utilized in this methodology. In order to use the decision model (Table 2), the circumstances of a particular obsolescence case must be determined. For example, the last known source plans to cease production in two months, there are no plans to replace the component or to redesign the system, the component is not considered complex, required quantities are substantial, and funding is not available. In this case, the applicable characteristics will be short time, stable, low cost, not complex and large quantity.

There are three steps for progressively narrowing the range of available alternatives when considering a particular situation. First, the (+), (-),, and (0) weights from Table 2 for each alternative are summarized at the far right of the model. (Table 3 illustrates this procedure.) Alternatives with any (-) indicators will be excluded from further consideration because they cannot favorably satisfy analysis

TABLE 3

DECISION PROCESS ILLUSTRATING THE SELECTION OF APPROPRIATE ALTERNATIVES

| | TIME | | STABILITY | | COST | | QUANTITY | | COMPLEXITY | | SUMMARY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Short | Long | Stb. | Not Stb. | Low | High | Small | Large | Not Cpx. | Cpx. | |
| Original Producer | + | 0 | + | + | + | - | + | + | + | + | 5(+) * |
| Contractor Find Another Source | + | 0 | + | - | + | + | 0 | + | + | 0 | 4(+) 1(0) * |
| Government Find Another Source | - | + | + | - | 0 | + | - | + | + | 0 | 2(+) 1(0) 2(-) |
| Develop New Source | - | + | + | - | - | + | - | + | + | 0 | 2(+) 3(-) |
| Specialty House | + | 0 | + | - | + | - | + | 0 | + | + | 5(+) * |
| In-House Production | - | + | + | - | - | + | - | + | + | 0 | 2(+) 3(-) |
| Substitute | + | 0 | + | - | + | - | 0 | + | + | + | 4(+) 1(0) * |
| Emulate | - | + | + | - | - | + | - | + | + | 0 | 2(+) 3(-) |
| Redesign | - | + | N/A | N/A | - | + | - | + | 0 | + | 3(-) 1(0) |
| Supply System | + | - | - | + | + | - | + | - | + | 0 | 4(+) 1(-) |
| Cannibalize | + | - | - | + | + | - | + | - | + | 0 | 4(+) 1(-) |
| Buy Out Production Life-time Quantity | + | 0 | + | - | - | + | - | + | 0 | + | 2(+) 1(0) 2(-) |
| Buy Out Until Redesign | + | 0 | - | + | + | 0 | + | 0 | 0 | + | 3(+) 1(0) 1(-) |
| Buy Semi-Finished Product | 0 | + | + | - | + | 0 | - | + | + | 0 | 3(+) 1(0) 1(-) |

Source: Developed by researcher

generated through combined assessment of the five factors. In this example, the (-) alternatives, "Government find another source," "develop new source," "in-house production," "emulate," "redesign," "buyout production life-time quantity," and "buy semi-finished product" will not fit the short time period allowed for analysis and implementation. Cannibalization and using supply system assets are never considered appropriate permanent solutions, and "buyout until redesign" is not a rational decision because there are no plans to redesign the system. Alternatives with (+) and (0) indicators include "original producer," "contractor find another source," "specialty house," and "substitute." The second step involves determining which of those selected (+) and (0) alternatives is most appropriate by considering the relative importance of particular factors. For example, if time is considered more important than the other four factors, there may be some alternatives with (0) indicators in the short time column which would be considered less desirable than those with (+) indicators. In this example, all alternatives originally selected because of their total of five (+) and (0) indicators have (+) indicators in the short time column, and no further elimination can be made by examining the most significant factor. The third step for narrowing the range of alternatives involves examination of the "within category" selection thought process explained in Chapters IV and V. The first three alternatives with (+) and (0) indicators are "original producer," "contractor

find another source," and "specialty house." These are from the Source Solution category. Following the order of consideration previously explained in the first part of Chapter IV, an effort should first be made to see if the original producer can be persuaded to continue production. If not, then the prime contractor should attempt to locate another source, and the availability of a specialty house should be assessed. Concurrent with this decision process, the feasibility of the fourth alternative, "substitution," from the Engineering Solutions category can be explored.

The capability to select one of these alternatives depends upon the willingness of the original supplier to continue production, and the actual availability of another source, a specialty house, or a substitutable item. If more than one of these alternatives is possible, consideration must be given to circumstances peculiarly unique to the situation and to the conditions inherent in each alternative. For example, the original producer may be willing to continue production for only a short time. Since the component will be needed for a much longer period, selection of a substitute might be a better long-term choice. Perhaps the prime contractor has found another source, but will have to make configuration changes to interest the source in producing the item. In this case, the intricacies of configuration change must be weighed against implementation implications of the other possible alternatives. Use of the model assists with narrowing the range of available

alternatives to those most suited to the particular circumstances. However, judgment is still required to make the final selection. There are too many circumstantial variables to enable final alternative selection to be made entirely through the use of a model.

## E. SUMMARY

The model presented in this chapter provides a method for analyzing and selecting "between category" alternatives. The assignment of weights to each factor is a subjective process based upon analysis presented in Chapters IV and V. The choice of alternatives is guided to a significant extent by a combination of circumstances surrounding each particular situation. The model condenses the circumstances into five factors, arrays the alternatives from all four categories, and weights the alternatives in relation to each factor characteristic. The assignment of weights enables the assessment of the overall applicability of each alternative to specific obsolescence situations. The model allows the consideration of the relative importance of each factor to particular obsolescence situations, and enables the identification of the most feasible alternatives in light of combined circumstances.

## VII. CONCLUSIONS AND RECOMMENDATIONS

### A. CONCLUSIONS

As a result of this research, the following conclusions have been drawn.

Obsolescence is a problem which affects the uninterrupted continuity of major weapon system production. As discussed in Chapter II, technology life cycles are significantly shorter than major weapon system life cycles. Component producers predictably phase-out production of older technology items to concentrate upon more profitable newer technology products. As a result, the decreasing availability of required components threatens major weapon system production line continuity.

Procedures for the identification, analysis and selection of alternative solutions to the obsolescence problem are not structured. As explained in Chapter III, current procedures are directed toward identifying affected systems and notifying users and producers that obsolescence is pending. The affected managers possess general guidelines for approaching problem resolution, but have no structured procedure which accommodates the methodical identification, analysis, and selection of alternative solutions.

Alternatives can be categorized, and a hierarchical decision thought process can be distinguished within each category. Chapter IV identifies the categories as: Source Solutions, Engineering Solutions, System Solutions, and Stockpile Solutions.

Chapters IV and V illustrate that, within each category, consideration of alternatives progresses from the least to the most disruptive impact upon the system and current procedures.

It is possible to use a decision model to assist with the resolution of particular obsolescence problems. A decision model has been developed in Chapter VI which can be used to eliminate inappropriate alternatives and to select those most suited to the particular situation.

Established procedures are often too time-consuming to allow adequate analysis of all options prior to the "last buy" opportunity. Problems which cannot be resolved at the prime contractor level are elevated to the program office where logistics, engineering and contracting personnel analyze the situation, decide upon a solution, and then inform the prime contractor as to the selected course of action. Experience has shown that the program office analysis often extends past the "last buy" date, no uniform decision is provided to the prime contractor, and the prime contractor feels compelled to act independently to protect the production line.

The need to resolve the obsolescence problem quickly may preclude the consideration of alternatives which take time to analyze and implement. A short time between notification and "last buy" date will cause alternatives involving the development of a new source, in-house production, emulation, and redesign not to be considered.

## B. RECOMMENDATIONS

As a result of this research effort, the following recommendations are presented.

An array of possible alternatives, advantages and disadvantages associated with each, and a decision process to assist with initial analysis should be available to each functional area tasked with participating in the decision process. Awareness of a range of potential solutions will expand each analyst's perception of the obsolescence problem, and allow the consideration of various alternatives to be conducted from a broader perspective than would be possible if only the most immediately apparent options were examined. A list of most common alternatives, factors associated with their analysis, and a decision model have been presented in Chapters IV, V, and VI of this study. This analysis of solutions to the obsolescence problem is intended to provide a useful base for identifying possible solutions, analyzing their applicability to particular situations, and selecting the most appropriate alternatives.

The analysis of alternatives should be started when the original producer is still contemplating discontinuing an item, and has not officially announced a final production run date. The opportunity to effectively identify, analyze, select, and implement feasible alternatives hinges upon the time provided between the producer's notification of plans to cease production and the "last buy" date. It is crucial for Government

and prime contractor personnel to ensure that this time period is as extensive as possible. Efforts must be made to encourage the producers to notify designated Government activities if they are even contemplating discontinuing an item. By shouldering the overall coordination responsibility, the activities can determine if the producer is the sole source, notify all users, and stimulate the analysis of alternatives well in advance of the actual production phase-out. This will allow the consideration of options normally excluded from analysis due to limited time to react.

Coordinate the decision process within the program manager's office so that a definitive answer is provided to the prime contractor before the "last buy" date. When the problem is elevated from the prime contractor to the program office, the maximum amount of time which can be taken to resolve the problem should be noted. The program manager should immediately task logistics, engineering, and contracting personnel to consider the feasibility of available options. As soon as possible, and especially before the "last buy" date, the program manager should meet with representatives from each area, select a solution, and notify the prime contractor as to the decision.

## C. SUMMARY OF ANSWERS TO RESEARCH QUESTIONS

The answers to the primary and subsidiary research questions are provided below.

Primary Research Question. What are the principal alternatives available to the Government to accommodate situations in which sources of supply for major weapon system components are no longer available, and how might these alternatives be analyzed to result in the best course of action?

Alternatives have been identified and categorized as follows:

1. Source Solutions
   a. Original producer
   b. Contractor find another source
   c. Government find another source
   d. Development of new source
   e. Specialty house
   f. In-house production
2. Engineering Solutions
   a. Substitution
   b. Emulation
   c. Redesign
3. System Solutions
   a. Navy supply system
   b. Cannibalization
4. Stockpile Solutions
   a. Buyout production life-time quantity
   b. Buyout until redesign
   c. Buy semi-finished product

Analysis of alternatives has been accomplished through the use of factors. Factors considered relevant to each category

of alternatives have been identified and discussed in Chapters IV and V. Chapter VI has consolidated the factors into five general areas which represent combined circumstances surrounding particular obsolescence problems. Alternatives which favorably withstand scrutiny from the perspective of these circumstances (time, stability, cost, quantity, and complexity) are considered viable options to consider as solutions to the obsolescence problem. Further analysis of these alternatives is accomplished by examining the progressive decision process inherent within each category of alternatives. Final alternative selection ultimately remains a process highly dependent upon judgment, yet the use of factor analysis provides valuable guidance for approaching the problem with an overall perspective, and assistance with eliminating alternatives which are not feasible.

Subsidiary Research Question #1. What are the typical conditions under which subcontractors are no longer sources of supply for major system components?

Chapter II has explained that life cycles of technologies are much shorter than the life cycles of major weapon systems. Consequently, sources of supply for major system components cease production of items which have passed the "maturity" phase of the life cycle, and concentrate upon producing components which represent the state-of-the-art in the industry. In the case of the semiconductor industry, Government requirements comprise a small, noninfluential share of the total

market. Microcircuit component producers do not find it profitable to continue supplying components needed by major weapon system producers when total market demand for these items is diminishing or nonexistent.

Subsidiary Research Question #2. What alternatives are available to resolve the problem of a subcontractor's discontinued production of a major system component?

A listing of available alternatives is provided as part of the answer to the primary research question. These alternatives are defined and discussed in Chapters IV and V.

Subsidiary Research Question #3. What are the key factors involved with selecting an alternative source, and how should these factors be used in the analysis?

Alternative sources have been categorized in Chapters IV and V, and key factors relevant to their analysis have been associated with each category. These factors are as follows: quantity, duration of production, design stability, complexity of system, component composition, proprietary data rights, configuration, test equipment, integrated logistics support, time, cost, availability, shelf-life, and storage. These factors are used to draw attention to all aspects of each alternative prior to deciding that the alternative should be selected as the best solution to a particular obsolescence problem.

Subsidiary Research Question #4. What is the decision process that could be used in selecting the best alternative?

Chapter VI describes a decision process which could be used. Five factors (time, stability, cost, complexity, quantity)

have been selected which represent combined circumstances surrounding a particular obsolescence problem. These factors are weighted in relation to each alternative. Alternatives with a total of (+) and (0) weights are considered potentially feasible. The identification of one particular circumstance which is more significant than the others will sometimes enable further reduction of potentially feasible alternatives. The last step in the decision process is to examine the progressive thought process inherent in each category of alternatives, and to select alternatives which are actually feasible given the circumstances.

D. AREAS FOR FURTHER RESEARCH

This study has identified and discussed the most commonly identified alternatives for resolution of the obsolescence problem, and presented a decision model to assist with alternative selection. All possible alternatives have not been included, and discussions have been general and relatively brief. It is suggested that further research:

1. Identify additional alternatives to the obsolescence problem,

2. Expand upon the discussions of each alternative.

This study has described the procedures that NAVAIR developed to approach the obsolescence problem, and the internal selection process. Further research could be directed toward:

1. Examining procedures other systems commands have implemented,

2. The development of internal selection processes which assure that sufficient analysis is conducted, and that a uniform decision is made and implemented.

This study has presented a decision model which does not consider many incremental aspects of particular situations. For example, time is either short or long. Many decisions could be affected by the inclusion of additional time, stability, cost, quantity, and complexity considerations. The model has other simplifying characteristics which could be revised to incorporate additional complexity. Suggestions for further research include:

1. Identify additional circumstantial factors whose combined consideration will affect alternative selection,

2. Conduct an in-depth analysis of the weighting scheme to determine if the (+), (-), (0) scheme is most appropriate, and whether the weights have been assigned in the most appropriate manner.

3. Determine a decision thought process which will objectively result in the ultimate selection of only one alternative solution to each particular obsolescence problem.

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